

## Space Software for Automotive Design

The spinoff-spurred growth of a chassis manufacturing company exemplifies the benefit potential of aerospace technology transfer

John Thousand, a consulting engineer serving the automotive industry (right), took on six unemployed aeronautical engineers who expanded and transformed his business by applying aerospace techniques and software to automotive design. Thousand's consulting firm is now a busy design and manufacturing operation producing automotive chassis and components.

In 1971, sharp reductions in the federal defense and space budgets created what was known as the "aerospace recession" that put thousands of aerospace engineers out of work. Traditionally the state with the largest aerospace employment, California was particularly hard hit. To ease the impact, the state government established a retraining program to prepare aerospace engineers for jobs in other industries.

That's how John Thousand wound up with six young aeronautical engineers who had previously worked for a California plant of the aerospace giant, McDonnell Douglas Corporation. Thousand was president of Wolverine Western Corporation, Newport Beach, California, a company providing engineering consulting services to the automotive industry. He didn't know it at the time, but his acquisition of the aerospace group was to start a chain of events that would transform

his company into a bustling design and manufacturing operation specializing in chassis for buses, trams, trucks, recreational vehicles and special purpose military vehicles. And aerospace spinoff would be the trigger.

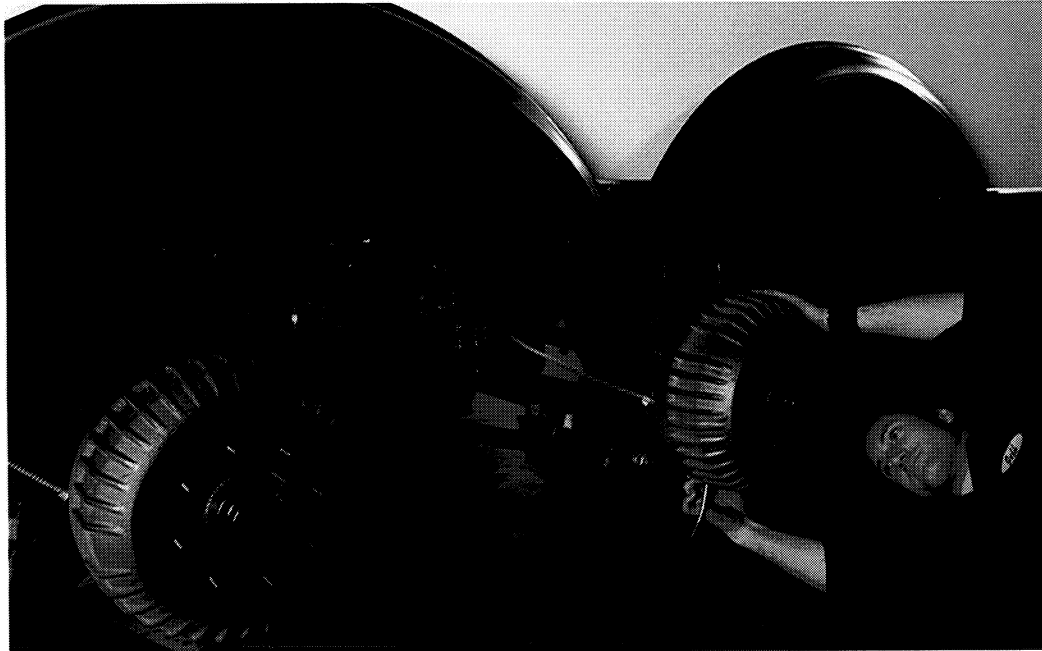
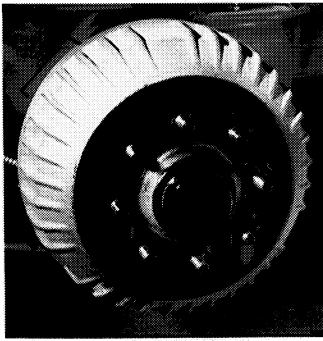
Thousand put his aerospace group to work on an unfamiliar job—designing a better brake drum—using computer design techniques with which they were entirely familiar. Used in the aerospace industry since the earliest days of the computer era, computer design involves creation of a mathematical model of a product and analyzing its effectiveness in simulated operation. The technique enables study of the performance and structural behavior of a number of different designs before settling on a final configuration.

The new Wolverine employees attacked a traditional brake drum problem—the sudden buildup of heat during fast and repeated brakings. The part of the brake drum that is not confined tends to change its shape under the combination of heat, physical pressure and rotational forces—a condition known as "bellmouthing." Since bellmouthing is a major factor in braking effectiveness, a solution to the problem would be a major advance in automotive engineering.

One of the group was Richard Hagen who, at McDonnell Douglas, had worked on NASA projects. He knew of a series of NASA computer programs that seemed ideally suited to the task of confronting bellmouthing. Originally developed as aids to rocket engine nozzle design, they were capable of analyzing the problems generated—in a rocket engine or an automotive brake drum—by heat, expansion pressure and rotational forces.

Use of these computer programs led to a new brake drum concept featuring a more durable axle and heat transfer ribs, or fins, on the hub of the drum. The ribs reinforce the shape of the drum and help prevent bellmouthing. Additionally, they act as cooling





Above, the principal product of Thousand's Wolverine Western Corporation: an advanced brake drum featuring a ribbed hub, a spinoff from rocket engine nozzle design technology. The ribs reinforce and cool the drum, helping to prevent a shape distortion known as "bellmouthing" that adversely affects braking efficiency. At left, a mechanic adjusts the brake shoes.

fins, allowing the brake to remain cooler during repeated braking on grades and thereby reducing brake fade or failure.

Hagen and his coworkers went a step further and applied computerized structural analysis to vehicle frames, using a computer program NASA had originally developed for early studies of an orbiting space station.

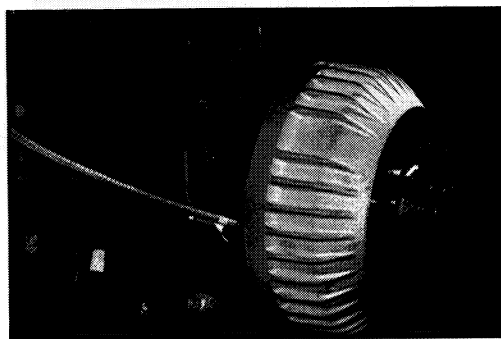
John Thousand approved the brake drum design and ordered patterns, prototypes and eventually castings. Sample drums were sent to Bendix Engineering Laboratories for test, and under intense dynamometer testing they never failed. Thousand's Wolverine Western Corporation was in the brake drum business.

In time, Wolverine's aerospace engineers moved on to other pursuits, but the innovations they left behind dramatically changed the company. In the years since, John Thousand has done less and less consulting and more and more manufacturing of the brake drums, axles and vehicle frames designed by his retrained aerospace engineers. Wolverine Western incorporates these parts in complete high quality chassis for a variety of automotive applications: for military command, control and communications centers; for intelligence vehicles; and for multipurpose vehicles that can be airlifted on military transports. In the civil sector, Wolverine chassis are used in buses, recreational vehicles and delivery trucks; they are also sold as turnkey medical diagnostic facilities, providing, for example, mobile eye examination or mammography (breast x-ray) services.

*(Continued)*



Above, a design conference at Wolverine Western. The aerospace engineers who revolutionized the company are no longer around, but the spinoff computer programs they introduced are still in use. They analyze the effects of various loads on each vehicle frame produced, since virtually every Wolverine vehicle is customized.



A Wolverine brake drum view from a different angle. The company's chassis employ the spinoff drum brakes on rear axles, disc brakes on the front.

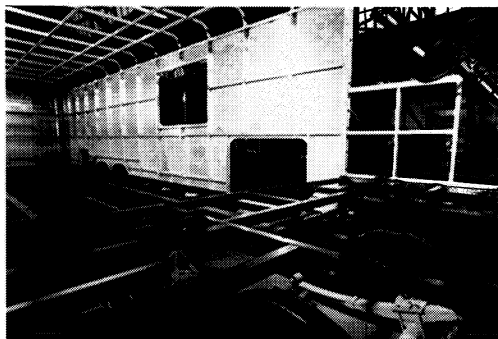
"When you think about it," says Wolverine Western Corporation's John Thousand, "a rocket nozzle has the same job to perform as a brake drum. They must both resist internal pressure forces and be efficient distributors of heat."

Many other high technology systems similarly share characteristics, in a general way, with non-aerospace products or processes in everyday civil use. That's why it is possible to reuse computer programs developed by NASA and other technology generating agencies of the government. Sometimes, as was the case with Wolverine Western, they can be applied to a secondary use with little or no change; in other instances, the program may have to be modified for a new use but that can most likely be done at far less than the cost of developing a new program.

Since thousands of companies each year are joining the ranks of computer users, NASA serves the interests of national productivity by offering these newcomers to computerization a way to effect significant reduction of their automation costs through purchase of already developed computer programs that have secondary utility.

This service is provided by NASA's Computer Software Management and Information Center (COSMIC)<sup>®</sup>. Located at the University of Georgia, COSMIC gets a continual flow of government developed software, identifies those programs that can be adapted to secondary usage, and stores some 1,400 of them. A COSMIC customer can purchase a program at a fraction of its original cost and get a return many times the investment, even when the cost of adapting the program to a new use is considered. This service has become one of the principal areas of technology transfer, as is evidenced by the fact that COSMIC sells about 700 software packages a year (see page 140).

Although it involves software rather than hardware, the Wolverine Western story is an



A vehicle frame under construction at Wolverine Western (left). The company's frame technology also originated in NASA software, initially developed to analyze space station configurations.

excellent example of the aerospace spinoff process. It illustrates two separate spinoff routes: one, the beneficial reuse of technology developed for the space program, and two, the personnel type of technology transfer, wherein aerospace workers move to other industries, bringing with them aerospace technology and skills that can be reapplied in their new occupations.

The Wolverine Western experience represents a high value spinoff due to creation of an entirely new product line. *Spinoffs*—whether hardware or software—with values in millions are not unusual, nor is the establishment of whole new companies based on technology transfers. In other cases, spinoffs generate only moderate economic gain but provide significant public benefit in other ways, ranging from simple conveniences to important developments in medical and industrial technology.

This year NASA marks the 25th anniversary of its Technology Utilization Program, which seeks to encourage the secondary application of aerospace technology for benefit to the national economy in the form of new products, new processes, new jobs and substantial contributions to the Gross National Product. During the quarter century of the program's existence, more than 30,000 aerospace-originated innovations have found their way into everyday use. Collectively, these spinoffs represent a significant return on the national investment in aerospace research and development, in terms of economic gain, industrial efficiency and productivity, lifestyle enhancement and solutions to problems of public concern. ▲



At top is a completed Wolverine Western vehicle with its distinctive lowered chassis. Above, a military vehicle is being loaded aboard an Air Force C-130 transport; all Wolverine vehicles built for military use are designed for air transportability.

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